

REMARKS

The application has been reviewed in light of the Office Action dated September 25, 2003. Claims 2-22 are pending in this application, with claims 7-12 having been withdrawn by the Patent Office from consideration. Claim 1 was previously cancelled, without prejudice or disclaimer. By this Amendment, claims 3, 6 and 15 have been amended hereby to present the claims in better form for examination. Accordingly, claims 2-6 and 13-22 are presented for examination, with claims 13, 19, and 20 being in independent form. It is submitted that no new matter has been introduced by the present amendment.

Claim 6 was objected to as purportedly having an informality of reciting an intended use.

Claim 6 has been amended hereinabove to clarify the claimed invention.

In view of the claim amendment, withdrawal of the objection to claim 6 is requested.

Claims 3 and 15 were rejected under 35 U.S.C. §112, second paragraph, as purportedly indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. Claims 3 and 15 were rejected under 35 U.S.C. §112, second paragraph, as allegedly incomplete for omitting essential elements, amounting to a gap between elements.

The claims have been amended hereinabove to clarify the claimed invention.

Accordingly, withdrawal of the rejections under 35 U.S.C. §112, second paragraph, are respectfully requested.

Claims 2-6 and 13-22 were rejected under 35 U.S.C. §103(a) as allegedly unpatentable over U.S. Patent No. 6,456,640 to Okumura in

view of International Patent Publication No. WO 98/44539 (corresponding to U.S. Patent No. 6,358,822 to Tomomura) and U.S. Patent No. 4,713,493 to Ovshinsky.

Applicant has carefully considered the Examiner's comments and the cited art, and respectfully submits that the claims are patentable over the cited art, for at least the following reasons.

As an initial matter, Applicant respectfully points out that Okumura and Tomomura are not prior art to this application.

This application claims the benefit of priority under 35 U.S.C. §119 from Japanese Application No. 10-293105, filed September 30, 1998. The U.S. filing date of U.S. Patent No. 6,456,640 to Okumura is January 21, 1999. The publication date of International Patent Publication No. WO 98/44539 (corresponding to U.S. Patent No. 6,358,822 to Tomomura) is October 8, 1998. Thus, the effective reference dates (January 21, 1999 and October 8, 1998) of Okumura and Tomomura, respectively, do not predate the September 30, 1998 priority date of this application.

In addition, Applicant maintains that the cited art does not disclose or suggest the claimed invention.

This applications relates to semiconductor devices which are suitable for use in, for example, self-pulsating laser device applications. Optical disk systems which use a laser diode can experience excessive noise from optical feedback. The noise can be minimized by modulating the laser output at a high pulse repetition rate, such as by including a saturable absorber in the cavity to induce self-pulsation.

The application embodies Applicant's recognition that mixed crystals have properties of particular importance in the field of semiconductors. More particularly, as discussed in the application, by

using a mixed crystal including a group-V element and nitrogen, a saturable absorbing layer having a band gap slightly different from that of the active layer while having a lattice constant almost the same as that of the active layer can be easily formed. In addition, a saturable absorbing layer having such properties can facilitate stable self-pulsations.

Independent claim 13 is directed to a semiconductor device which includes a semiconductor substrate of a first conductivity type, a first cladding layer of the first conductivity type formed on the semiconductor substrate, an active layer formed on the first cladding layer, a second cladding layer of a second conductivity type formed on the active layer, and a saturable absorbing layer formed on at least portions of at least one of the first cladding layer and the second cladding layer. The saturable absorbing layer is a mixed crystal of nitrogen with another group-V element and is formed to have a band gap energy either approximately the same as, or slightly smaller than, the active layer.

The cited art does not disclose or suggest the claimed invention.

Okumura, as understood by Applicant, is directed to a semiconductor laser device which has a layered structure formed on a substrate. The layered structure includes an active layer of a nitride type semiconductor material which is interposed between a pair of nitride type semiconductor cladding layers.

Okumura discloses a conventional semiconductor laser device which includes a saturable absorbing layer of InGaN. However, according to Okumura, a semiconductor laser device which includes a saturable absorbing layer has a reduced emission efficiency, and has an irregular far field pattern when only one saturable absorbing layer is added.

Accordingly, Okumura teaches a semiconductor laser device which does not have a saturable absorbing layer and has a structure, different from conventional semiconductor laser devices that do not have a saturable absorbing layer, which purportedly avoids the problem of noise from return light.

The Office Action acknowledges that Okumura does not disclose adding a group V element to a saturable absorbing layer and is silent regarding the band gap of the saturable absorber.

Tomomura, as understood by Applicant, is directed to a method of manufacturing a III-V compound semiconductor, by irradiating a substrate with molecular beams of source materials in a growth chamber to grow III-V compound semiconductor crystal including nitrogen and another group V element. Tomomura discloses that III-V compound semiconductors which include nitrogen and another group V element are attractive as optoelectronic materials because of the lattice constants and energy bandgaps of the III-V compound semiconductor can be controlled in wide ranges by changing their mixed crystal compositions. According to Tomomura, GaInNAs has a bandgap desirable for an active layer of a semiconductor laser for optical fiber communication.

However, Applicant do not find teaching or suggestion in the cited art of a saturable absorbing layer formed on at least portions of at least one of the first cladding layer and the second cladding layer, wherein the saturable absorbing layer is a mixed crystal of nitrogen (N) with another group-V element and is formed to have a band gap energy either approximately the same as, or slightly smaller than, the active layer, as recited in independent claim 13.

Tomomura does not disclose or suggest that GaInNAs is suitable for a saturable absorbing layer. As mentioned above, Okumura teaches

that semiconductor laser devices which have a saturable absorbing layer experience undesirable effects. Therefore it simply would not have been obvious to make the combination or modification proposed in the Office Action, unless the application is impermissibly used as a roadmap to reconstruct the claimed invention from disparate elements in the prior art.

Ovshinsky, as understood by Applicant, is directed to a power generating optical filter, and was cited as support for the proposition that nitrogen is well known in the art as an element used in semiconductor layers for adjusting a bandgap.

However, Ovshinsky, like the other references, does not disclose or suggest a saturable absorbing layer formed on at least portions of at least one of the first cladding layer and the second cladding layer, wherein the saturable absorbing layer is a mixed crystal of nitrogen (N) with another group-V element and is formed to have a band gap energy either approximately the same as, or slightly smaller than, the active layer, as recited in independent claim 13.

In addition, Applicant maintains that it would not have been obvious for a person skilled in the art to use a material including N and another group V element for the saturable absorbing layer.

Okumura discloses a semiconductor laser having an InGaN active layer, wherein an InGaN saturable absorbing layer is provided therein. Okumura also discloses that an AlGaAs saturable absorbing layer is provided in a semiconductor laser having an AlGaAs active layer, and an AlGaInP saturable absorbing layer is provided in a semiconductor laser having an AlGaInP active layer. Therefore, it is clear that Okumura teaches that the active layer and the saturable absorbing layer in the semiconductor laser should be made of the same kind of material.

Tomomura discloses a semiconductor laser having an active layer made of a mixed crystal including N and As. One skilled in the art following the teachings of Tomomura might adapt a semiconductor laser to have an active layer including N and another group V element and a saturable absorbing layer including N and another group V element.

However, a semiconductor laser according to the present application has an active layer made of a material including no nitrogen atom, such as GaInP, and includes a saturable absorbing layer made of a material including N and another group V element, such as GaInNP. Namely, the active layer and the saturable absorbing layer are made of different materials. A semiconductor laser having such a constitution has the characteristics that a life of the carrier in the saturable absorbing layer is shorter than that in the active layer, thereby facilitating stable self-pulsations. The cited art simply does not disclose or suggest these features and advantages, and therefore the claimed invention simply would not have been obvious to one skilled in the art.

For at least the foregoing reasons, it is respectfully submitted that amended independent claim 13 is patentable over the cited art. Independent claims 19 and 20 are believed to be patentable over the cited art for at least similar reasons.


The Office is hereby authorized to charge any additional fees that may be required in connection with this amendment and to credit any overpayment to our Deposit Account No. 03-3125.

If a petition for an extension of time is required to make this response timely, this paper should be considered to be such a petition, and the Commissioner is authorized to charge the requisite fees to our Deposit Account No. 03-3125.

If a telephone interview could advance the prosecution of this application, the Examiner is respectfully requested to call the undersigned attorney.

Reconsideration and allowance of this application are respectfully requested.

Respectfully submitted,

  
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